Los Alamos National Laboratory Environmental Restoration Program Standard Operating Procedure

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Soil and Core pH

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SOIL AND CORE pH

1.0 PURPOSE

This procedure describes the methods by which the pH of a soil is measured. This procedure can be used to determine the degree of acidity or alkalinity in soil materials which are suspended in water and a 0.01M calcium chloride solution, and it can be used to supplement soil-resistivity measurements and identify conditions under which the corrosion of metals in the soil may be sharply accentuated.

2.0 SCOPE

2.1 Applicability

This procedure is applicable for determining the soil pH when collecting or working with soil samples for the Environmental Restoration program.

2.2 Training

Field team members using this procedure must document that they have read and understand this procedure and the procedures in Section 1.0, General Instructions.

3.0 DEFINITIONS

There are no unique definitions in this procedure.

4.0 BACKGROUND AND/OR CAUTIONS

Refer to the attached ASTMs, and to the Site Health and Safety plan for hazards and/or cautions.

5.0 EQUIPMENT

Refer to the attached ASTMs.

6.0 PROCEDURE

Refer to the attached ASTMs.

The use of commercially available pH buffers and deionized water is acceptable in the procedures. Follow the manufacturer's instructions for calibration of the pH meters.

7.0 REFERENCES

The following procedures are directly associated with this procedure and should be reviewed prior to field operations:

ASTM STANDARD D4972-89. 1989. Standard Test Method for pH of Soils.

ASTM STANDARD D2976-71. 1971. Standard Test Method for pH of Peat Materials.

ASTM STANDARD G51-77. 1977. Standard Test Method for pH of Soils for Use in Corrosion Testing.

LANL-ER-SOPs in Section 1.0, General Instructions.

8.0 RECORDS

A Chain-of-Custody/Request for Analysis form (SOP-01.04) will be maintained and will document the following information:

- Field Sample Number
- · Date and time collected
- Sample container volume and material
- Matrix (soil, sludge, sediment)
- Test method
- Solution the pH datum was taken from

The laboratory will report:

- pH datum recorded to the first decimal
- Lot and expiration date of calibration solutions used
- Calibration records
- Soil size fractions taken from other than the No. 10 sieve.

9.0 ATTACHMENTS

- A. ASTM STANDARD D4972-89. 1989. Standard Test Method for pH of Soils.
- B ASTM STANDARD D2976-71. 1971. Standard Test Method for pH of Peat Materials.
- C. ASTM STANDARD G51-77. 1977. Standard Test Method for pH of Soils for Use in Corrosion Testing.

ASTM STANDARD D4972-89, STANDARD TEST METHOD FOR pH OF SOILS



Standard Test Method for pH of Soils1

This standard is issued under the fixed designation D 4972, the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval, A superscript epstion (e) indicates an editorial change since the last revision or reapproval

1. Scope

1.1 This test method covers the measurement of the pH of soils for uses other than for corrosion testing. Such measurements are used in the agricultural, environmental, and the natural resources fields. This measurement determines the degree of acidity or alkalinity in soil materials suspended in water and a 0.01 M calcium chloride solution. Measurement in both liquids are necessary to fully define the soil's pH. This variable is useful in determining the solubility of soil minerals, the mobility of ions in the soil, and assessing the viability of the soil-plant environment. A more detailed discussion of the usefulness of this parameter is not warranted here, however, it can be found in many discussions of the subject. A few such discussions are given as Refs (1)² through (6) at the end of the text.

1.2 The values given in SI units are regarded as standard.

1.3 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

- 2.1 ASTM Standards:
- C 670 Practice for Preparing Precision and Bias Statements for Test Methods of Construction Materials³
- G 51 Test Method for pH of Soil for Use in Corrosion Testing*

3. Summary of Test Method

3.1 Measurement of the pH of soils in both suspensions of water and a calcium chloride solution are made with either a potentiometer using a pH sensitive electrode system (Method A), or pH sensitive paper (Method B). The potentiometer is calibrated with buffer solutions of known pH. The pH sensitive paper is a less accurate measurement and should only be used for a rough estimate of the soil pH. The electrode must be used for this measurement unless the pH sensitive paper is specified.

4. Significance and Use

4.1 The pH of the soil is a useful variable in determining

the solubility of soil minerals, the mobility of ions in the soil. and assessing the viability of the soil-plant environment.

- 4.2 pH measurements are made in both water and a calcium chloride solution, because the calcium displaces some of the exchangeable aluminum. The low ionic strength counters the dilution effect on the exchange equilibrium by setting the salt concentration of the solution closer to that expected in the soil solution. The pH values obtained in the solution of calcium chloride are slightly lower than those measured in water due to the release of more aluminum ions which then hydrolyses. Therefore, both measurements are required to fully define the character of the soil's pH.
- 4.3 For the purpose of this test method the test soil must be sieved through a No. 10 sieve (2 mm sieve mesh openings). Measurements on soils or soil fractions having particle sizes larger than 2 mm by this test method may be invalid. If soil or soil fractions with particles larger than 2 mm are used, it must be stated in the report since the results may be significantly different.
- 4.4 All water used for this test method must be distilled and deionized.

5. Interferences

- 5.1 This test method as measured by a pH probe has possible interferences due to a suspension effect or sedimentation potential. Users interested in a detailed discussion of the mechanism of this effect can find it in Refs (5) and (6).
- 5.2 This effect is the main reason Test Method G 51 can not be used for general measurement of pH outside of that for corrosion analysis. Test Method G 51 measures pH (an aqueous parameter) without adding any aqueous phase to the soil. This results in excessive soil particle-pH probe contact that over-estimates the activity of the hydrogen ions in solution and is therefore unacceptable for general soil
- 5.3 The suspension effect can be mitigated by careful attention to 9.1.

6. Apparatus

- 6.1 Method A. pH Meter-Potentiometer equipped with glass-calomel electrode system. Follow the manufacturer's instructions for the pH meter used. A silver/silver chloride electrode system or similar is also acceptable.
- 6.2 Method B. pH Paper—pH paper sensitive to a pH range from 1 to 12, with resolution to the nearest 0.2 pH unit.

7. Reagents

7.1 Purity of Reagents-Reagent grade chemicals should be used in all tests. Unless otherwise indicated, it is intended that all reagents should conform to the specifications of the

¹ This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.06 on Physico-Chemical Properties of Soils and Rocks.

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² The boldface numbers in parentheses refer to a list of references at the end of the test method.

³ Annual Book of AST:W Standards, Vols 04.01, 04.02, 04.03, and 04.08. ⁴ Annual Book of AST:M Standards, Vol 03.02.

♠ D 4972

Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.⁵ Other grades may be used, provided it is first ascertained that the reagent is of sufficient purity to permit its use without lessening the accuracy of the determination.

- 7.2 Purity of Water—Water should be distilled, deionized water, but not necessarily free of carbon dioxide. The pH of the water should be checked prior to testing the soil. Should it fall outside the range of 6.5 to 7.5, it should be discarded and other water obtained for the test.
- 7.3 Acid Potassium Phthalate Buffer Solution (0.05 M)—Dissolve 10.21 g (dried 1 h at 105°C) of potassium phthalate in water and dilute to 1 L. The pH of this solution should be 4.0 at 20°C. Protect the solution against evaporation and against contamination with molds. Replace the solution when mold is noticed. The effect of temperature is:

This illustrates that the pH of the solution does not change over the range in temperature from 5 to 37°C.

- 7.4 Calcium Chloride Stock Solution (1.0 M)—Dissolve 147 g of CaCl₂*2H₂O in water in a 1-L volumetric flask, cool. dilute to volume with water, and mix. Dilute 15 mL of this solution to 200 mL with water in a volumetric flask.
- 7.5 Calcium Chloride Solution (0.01 M)—Dilute 20.0 mL of stock 1.0 M CaCl₂ solution to 2 L with water. The pH of this solution should be between 5 and 7.
- 7.6 Phosphate Buffer Solution (0.025 M)—Dissolve 3.40 g of KH₂PO₄ and 3.55 g of Na₂HPO₄ in water and dilute to 1 L. Dry salts 2 h at 130°C before use. The pH of this solution should be 6.9 at 20°C. The effect of temperature is as follows:

° C	рН
0	7.0
10	6.9
20	6.9
30	6.8
40	6.9

8. Calibration of pH Meter

8.1 Calibrate the pH meter using the acid potassium phthalate and phosphate buffer solutions. Adjustment of the pH meter should follow the manufacturers direction.

9. Procedure

- 9.1 When making measurements with the pH electrode, place the electrode into the partially settled suspension to mitigate the suspension effect.
- 9.2 For both methods, begin with an air dried soil that has been sieved through a No. 10 sieve (2 mm holes) to remove the coarser soil fraction. Air drying the soil is necessary to accomplish sieving and to control the amount of water present at the time of measurement.
- 9.3 pH in Distilled Water—For both methods, weigh out approximately 10 g of air dried soil. Place the soil into a glass container and add approximately 10 mL of distilled water.

Mix thoroughly and let stand for 1 h.

- 9.4 Method A-Read pH on pH meter.
- 9.5 Method B-Read pH on pH paper.
- 9.6 pH in 0.01 M Calcium Chloride Solution—For both methods weigh out approximately 10 g of air dried soil. Place the soil into a glass container and add approximately 10 mL of the 0.01 M CaCl₂ solution. Mix thoroughly and let stand for 1 h.
 - 9.7 Method A-Read pH on pH meter.
 - 9.8 Method B-Read pH on pH paper.
- 9.9 The mixture should be at approximately room temperature (15 to 25°C) at the time of pH measurement.

10. Report

10.1 Report the pH of the soil to the first decimal place. Specify which of the pH measurements is in water and which is in the calcium chloride solution. Also specify whether the determinations were made with Method A or Method B. If size fractions other than sieved through the No. 10 sieve are used, it must be stated in the report since the results may be significantly different.

11. Precision and Bias

- 11.1 Precision:
- 11.1.1 Within-Laboratory Precision—The within laboratory standard deviations for Method A are 0.031 (pH units) for the water mixture and 0.1396 (pH units) for the calcium chloride mixture. Therefore, results of two properly conducted tests in the same or different laboratories should not differ by more than 0.0656 (pH units) for the water mixture and 0.389 pH units for the calcium chloride mixture. The within-laboratory standard deviations for Method B are 0.189 (pH units) for the water mixture and 0.2126 (pH units) for the calcium chloride mixture. Therefore, results of two properly conducted tests in the same or different laboratories should not differ by more than 0.536 (pH units) for the water mixture and 0.60 pH units for the calcium chloride mixture.
- 11.1.1.1 The precision of Method A presented was determined by the National Technical Center of the United States Department of Agriculture. In their evaluation they used 174 replicates for the water mixture and 32 replicates in testing the calcium chloride mixture.
- 11.1.1.2 The precision of Method B presented was determined by the United States Army Environmental Hygiene Agency. In their evaluation they used 25 replicates in testing each mixture.
- 11.1.2 Between-Laboratory Precision—The between-laboratory standard deviation has not been determined for either method. Subcommittee D18.06 is actively seeking data to evaluate the between laboratory precision of this test method.
- 11.2 Bias—There is no accepted reference value for this test method; therefore, bias cannot be determined.

12. Keywords

12.1 soil; pH; acidity; alkalinity; reaction

^{5 &}quot;Reagent Chemicals, American Chemical Society Specifications," Am. Chemical Soc., Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards, by Joseph Rosin, D. Van Nostrand Co., Inc., New York, NY, and the United States Pharmacopeia.

⁶ These data satisfy the 1S and D2S requirements outlined in Practice C 670.

₽ D 4972

REFERENCES

- (1) Garrels, R. M., and Christ, C. L., Solutions, Minerals, and Equilibria," Freeman Cooper, San Francisco, CA, 1965.
- (2) Greenland, D. J., and Hayes, M. H. B., The Chemistry of Soil Processes, Wiley, NY, 1981.
- (3) Sposito, G., The Thermodynamics of Soil Solutions, Clarendon, Oxford, 1981.
- (4) Davies, J. T., and Rideal, E. K., Interfacial Phenomena, Academic, NY, 1963.
- (5) Hunter, R. J., Zeta Potential in Colloid Science, Academic, NY, 1981.
- (6) Perrin, D. D., and Dempsey, B., Buffers for pH and Metal Ion Control, Chapman and Hall, London, 1974.

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ASTM STANDARD D2976-71, STANDARD TEST METHOD FOR pH OF PEAT MATERIALS



Designation: D 2976 - 71 (Reapproved 1981) $^{\epsilon 1}$

Standard Test Method for pH of Peat Materials¹

This standard is issued under the fixed designation D 2976; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (4) indicates an editorial change since the last revision or reapproval.

61 Note-Footnote 2 and Section 9 were added editorially in May 1981.

1. Scope

1.1 This method² covers the electrometric measurement of the pH of peat materials. It is a means of expressing the degree of acidity or alkalinity of peat material suspended in water and 0.01 M calcium chloride solution.

2. Summary of Method

2.1 The electrometric measurement of the pH of peat in suspensions of water and calcium chloride solutions is made with a potentiometer using a glass-calomel electrode system, calibrated with buffers of known pH.

3. Significance

3.1 pH measurements are made in water and in calcium chloride solution because the pH readings in water can be modified by salts such as fertilizer material whereas the observed pH in calcium chloride solution is virtually independent of the initial amount of salts present in the soil. pH values obtained in calcium chloride solution usually run about a 0.5 to 0.8 pH unit lower than measurements in water due to release of more hydrogen ions by cation exchange.

4. Apparatus

4.1 pH Meter—Potentiometer equipped with glass-calomel electrode system. Follow the manufacturer's instructions for the pH meter used.

5. Reagents

5.1 Purity of Reagents—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.³ Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.2 Purity of Water—Water shall be carbon-dioxide-free distilled water. Use water with a pH of not less than 6.5 nor

more than 7.5 obtained by boiling distilled water 15 min and cooling under carbon dioxide-free conditions.

5.3 Acid Potassium Phthalate Buffer Solution (0.05 M)—Dissolve 10.21 g (dried 1 h at 105°C) of potassium phthalate (NBS Standard Samples) in water and dilute to 1 L. Protect the solution against evaporation and contamination with molds. Replace the solution when mold is apparent. The effect of temperature is as follows:

° C	рН
5 to 24	4.00
25 to 33	4.01
34 to 37	4.03

5.4 Calcium Chloride, Stock Solution (1.0 M)—Dissolve 147 g of $CaCl_2 \cdot 2H_2O$ in distilled water in a 1-L volumetric flask, cool, dilute to volume with distilled water, and mix. Dilute 15 mL of this solution to 200 mL with distilled water in a volumetric flask, and standardize by titrating a 25-mL aliquot of the diluted solution with standard 0.1 N silver nitrate (AgNO₃) solution using 1 mL of 5 % potassium chromate (K_2CrO_4) solution as the indicator.

5.5 Calcium Chloride Solution (0.01 M)—Dilute 20.0 mL of stock 1.0 M CaCl₂ solution to 2 L with distilled water. The pH of this solution should be between 5 and 6.5.

5.6 Phosphate Buffer Solution (0.025 M)—Dissolve 3.40 g of KH₂PO₄ and 3.55 g of Na₂ HPO₄ (NBS Standard Samples 186-I and II) in water and dilute to 1 L. Dry salts 2 h at 130°C before use. Effect of temperature on pH is:

* C	рH
0	6.98
10	6.92
20	6.88
30	6.85
40	6.83

6. Calibration of pH Meter

6.1 Calibrate the pH meter using the acid potassium phthalate and phosphate buffer solutions.

7. Procedure

7.1 pH in Distilled Water—Weigh out about 3 g of air-dried peat or about the equivalent amount of moist material. Place into a 100-mL beaker. Add 50 mL of distilled water. Additional water may be needed for very fibrous materials such as sphagnum moss peat. Let soak with occasional stirring for 30 min. Read on pH meter.

7.2 pH in 0.01 M CaCl₂ Solution—Weigh out about 3.0 g of air-dried peat or the equivalent amount of moist material. Place into a 100-mL beaker. Add 50 mL of 0.01 M CaCl₂

 $^{^{\}rm 1}$ This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock.

Effective Sept. 20, 1971.

² This method is currently undergoing an extensive review by ASTM Committee D-18 and additional alternative methods will be proposed.

^{3 &}quot;Reagent Chemicals, American Chemical Society Specifications." Am. Chemical Soc., Washington, D.C. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards." by Joseph Rosin, D. Van Nostrand Co., Inc., New York, N.Y., and the "United States Pharmacopeia."



solution. Let soak with an occasional stirring for 30 min. Read on pH meter.

calcium chloride solution.9. Precision and Accuracy

8. Report

8.1 Report the pH of the peat to the first decimal place (0.1) and specify whether it is pH in distilled water or pH in

9.1 The precision of this method has not yet been determined. Data are being sought that will be suitable for use in developing precision statements.

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ASTM STANDARD G51-77, STANDARD TEST METHOD FOR pH OF SOILS FOR USE IN CORROSION TESTING



Standard Test Method for pH of Soil for Use in Corrosion Testing¹

This standard is issued under the fixed designation G 51; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

- 1.1 This method covers the determination of soil pH. The principal use of the test is to supplement soil-resistivity measurements and thereby identify conditions under which the corrosion of metals in the soil may be sharply accentuated.
- 1.2 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Apparatus

- 2.1 pH Meters—There are two types of meters: (1) potentiometric, which has a null indication, and (2) high-impedance amplifier type, which gives the pH directly (without null indication). Either meter is available as a portable, battery-powered unit so that it can be used in the field. The potentiometric meter is more accurate and generally more versatile.
- 2.2 Calomel and Glass Electrodes:
- 2.2.1 A saturated calomel reference electrode or its equivalent shall be used in the pH determination. A few crystals of solid potassium chloride should always be present within the chamber surrounding the calomel to assure that the solution is saturated under the conditions of use. The design of the electrode shall permit the formation of a fresh liquid junction between the solution of potassium chloride and the buffer or test soil for each test and shall allow traces of soil to be readily removed by washing.
- 2.2.2 A glass electrode of rugged construction is required. The pH response of the glass electrode shall be judged to be performing satisfactorily if it furnishes the correct pH value (±0.1 pH unit) for standard buffer solutions.
- Note 1—These standards can be purchased from chemical supply companies or pH equipment manufacturers in tablet or powder form such that when added to a measured amount of distilled water, the desired standard buffer solution is obtained.
- 2.2.3 A combination electrode consisting of a saturated calomel reference electrode and a glass electrode (items 2.2.1 and 2.2.2) combined as a single electrode is acceptable. However, the requirements outlined above are equally applicable to the electrodes used in this combination unit.

¹ This test method is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals, and is the direct responsibility of Subcommittee G01.10 on Corrosion in Soils.

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2.3 Subsurface Probe—When pH measurements below the surface of the soil are required, it is necessary to use a probe of suitable length which will allow measurements to be made at the depth of interest. This probe consists of a glass electrode or a combination electrode in a rubber housing at the end of a plastic tube. One type of probe is illustrated in Fig. 1.

3. Procedure

- 3.1 Test of Apparatus—Prior to field use, or periodically when used extensively in the field, test the apparatus for linearity of response. This procedure is as follows:
- 3.1.1 Turn on the instrument, allow to warm up thoroughly, and bring to electrical balance in accordance with the manufacturer's instructions. Before use, clean and rinse the glass and calomel electrodes in distilled water.
- NOTE 2—New glass electrodes and those that have been stored dry shall be conditioned in accordance with the manufacturer's recommendations before use.
- 3.1.2 At least two standard buffered pH solutions that span the soil pH to be measured are required. From practical experience standard solutions of pH 4, 7, and 8 are recommended. For the test, the temperature of these solutions shall not differ from each other by more than 5°C.
- 3.1.3 Adjust the temperature compensating dial on the pH meter to the standard solution temperature.
- 3.1.4 Immerse the electrodes in a small volume of the first known standard solution. Now adjust the meter to read this known pH by use of the "standardize" dial.
- 3.1.5 Remove the electrodes from the first standard solution, and rinse in distilled water. Immerse the electrodes in the second known standard solution. Judge the system to be operating satisfactorily if the reading obtained for the second standard agrees within 0.1 unit of the assigned pH.
- 3.2 Standardization of pH Meter—Standardize the pH meter immediately before use. If a series of measurements are to be made, supplement initial standardization by a check at intervals of about 30 min. Perform the meter standardization as follows:
- 3.2.1 Use a standard solution in the range of the pH of the soil to be tested, if such information is known beforehand. Otherwise, begin with a standard solution having a pH of 7. Stabilize the temperature of the solution so that it matches the temperature of the soil to within 10°C.
- 3.2.2 Immerse the electrodes in the known standard solution and adjust the meter to read this known pH, using the "standardize" dial.
- 3.3 Soil Preparation for pH Determination:
- 3.3.1 Ideally the pH measurement should be made in the field on undisturbed soil with the glass electrode contacting the soil at the specific depth of interest. If the surface soil pH

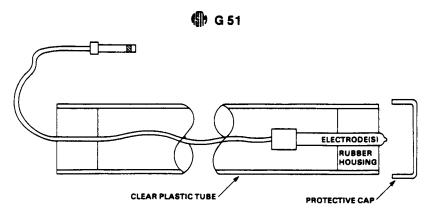


FIG. 1 Subsurface Probe

is desired, then the soil can be broken up if compacted so as to accept the electrodes. If a subsurface pH is desired, then a boring or an excavation must be done so that the electrode can be placed in the soil at the desired depth. The subsurface probe (Fig. 1) is ideal for use with a boring tool such as a hand auger. After the boring is done, carefully lower the probe into the cavity without further preparation of the soil.

- 3.3.2 Soil samples can be brought to the surface with a boring tool or a post-hole digger, and the measurement made in the field on the soil thus obtained. This technique is less desirable than the probe method described above.
- 3.3.3 The least desirable pH measurement of soil is that which is based on a soil sample transported to a laboratory for evaluation. However, if this must be done, then make the pH measurement as quickly as possible after the soil is taken from the field. Place the sample in a clean, airtight, glass container or plastic bag so that the soil is not in contact with any metal. If the pH measurement is not made within 24 h from the time the soil sample is taken, then it is recommended that the soil sample be packed in dry ice to retard any change in pH due to chemical or biological reactions. Make the pH measurement on the soil at room temperature and as received.
- 3.3.3.1 The addition of water to the soil is not recommended for any case because some soils are so poorly buffered that added moisture will change their pH. However, if a soil is extremely dry with a resistivity exceeding 106

 Ω -cm, a condition not likely to be encountered, then the pH measurement cannot and should not be made. This situation will manifest itself with a random drifting of the pH meter reading.

- 3.4 Determination of pH of Soil:
- 3.4.1 Complete the meter standardization procedure (3.2). The soil temperature shall match the temperature of the standardizing solution within 10°C. However, maintain the temperature compensating dial on the meter at the setting used for standardization.
- 3.4.2 Clean the electrode surface by washing with distilled water
- 3.4.3 Press the contact area of the glass electrode or combination electrode, as the case may be, against undisturbed soil at the location of interest.
- 3.4.4 The reference electrode should be placed in contact with the soil near the glass electrode (this step is not required when using a combination-type electrode). An electrode separation of about 300 mm (1 ft) is suggested for surface measurements. For subsurface readings, the reference electrode may be placed on the surface about 300 mm from the bore hole entry.
- 3.4.5 With the electrode(s) in place, set the meter to read pH, allow a few minutes for equilibrium to be established, then take the meter reading.
- 3.4.6 After several minutes, repeat the meter reading. The values obtained should agree within 0.2 unit to be acceptable.

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